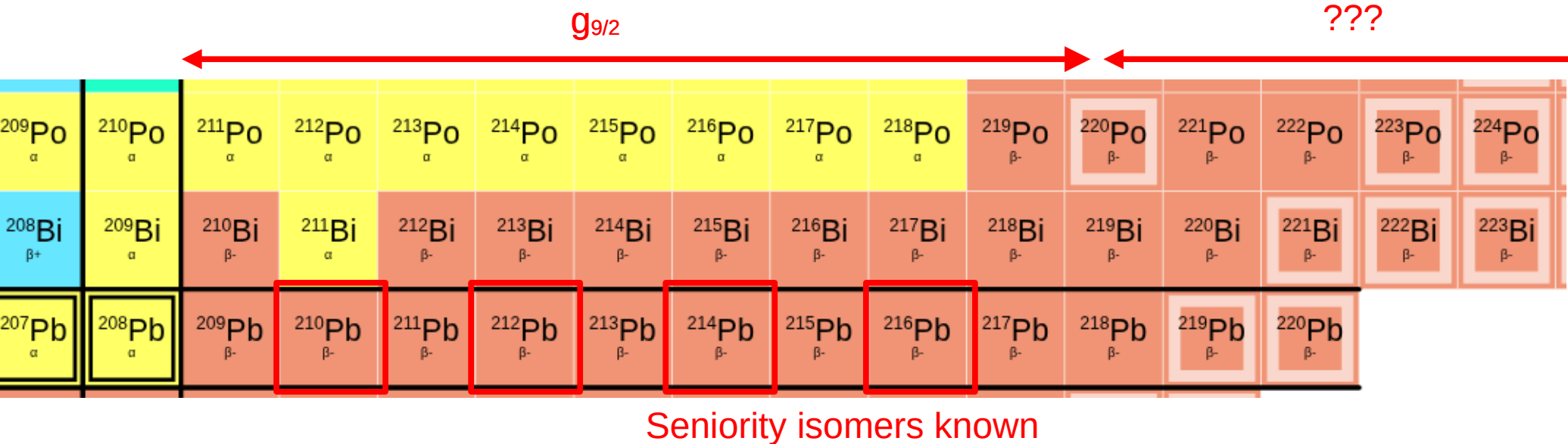


Isomers in the Pb region past $N=136$

e23064 update

e23064

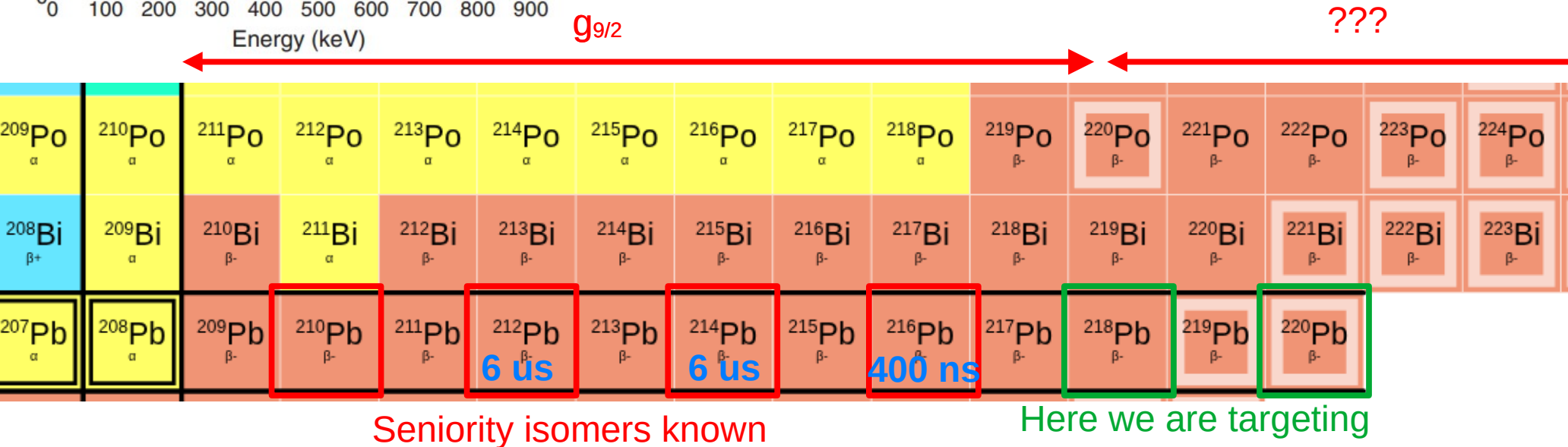
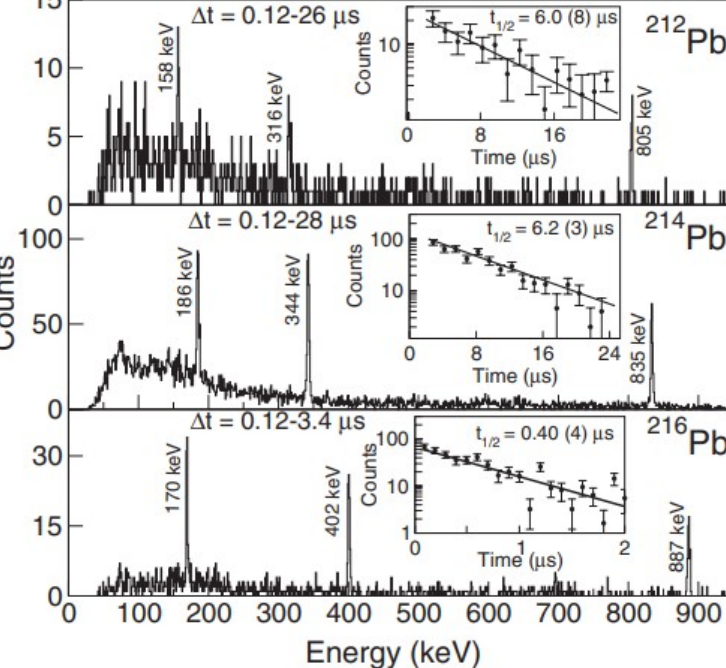
- FRIB Decay Station initiator experiment, ran July 2026
- PI: Allmond
- Search for isomers in Pb isotopes beyond N=136



Motivation

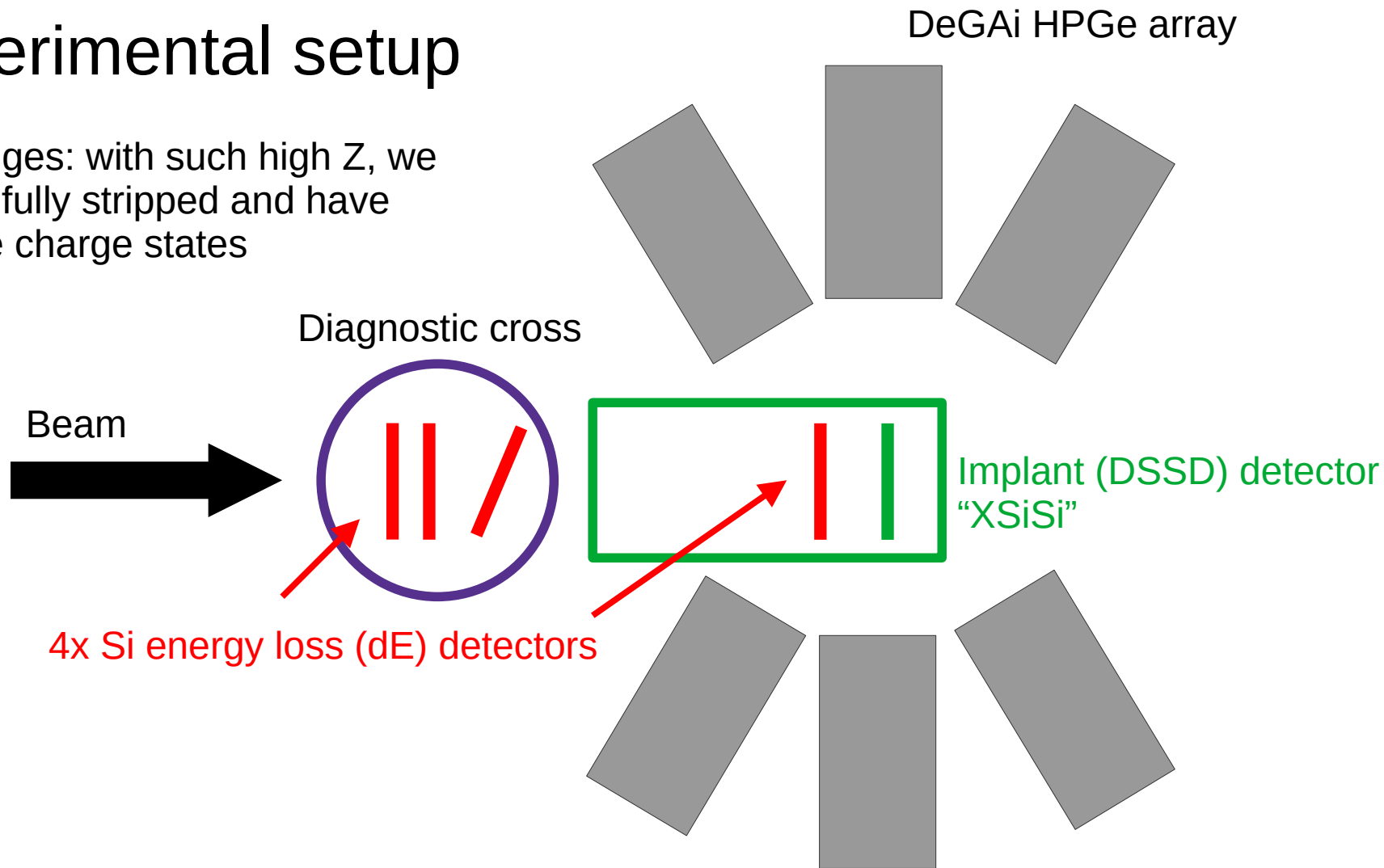
Lifetime decreases from ^{214}Pb to ^{216}Pb : **does ^{218}Pb have an isomer?**

Beyond ^{218}Pb ($N=136$), are there isomers → **these tell us about the next orbit**



Experimental setup

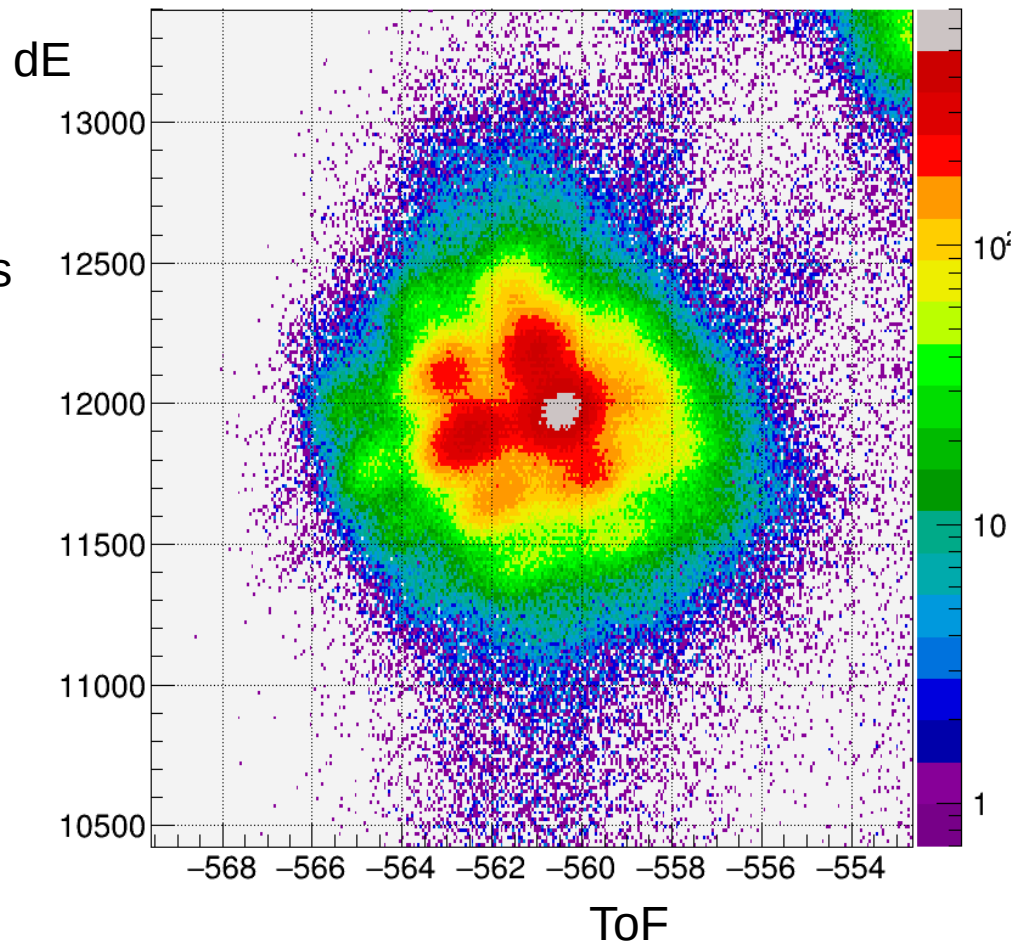
Challenges: with such high Z , we are not fully stripped and have multiple charge states



Analysis: Particle identification

“Basic” PID

- poor resolution
- each “blob” actually contains multiple isotopes



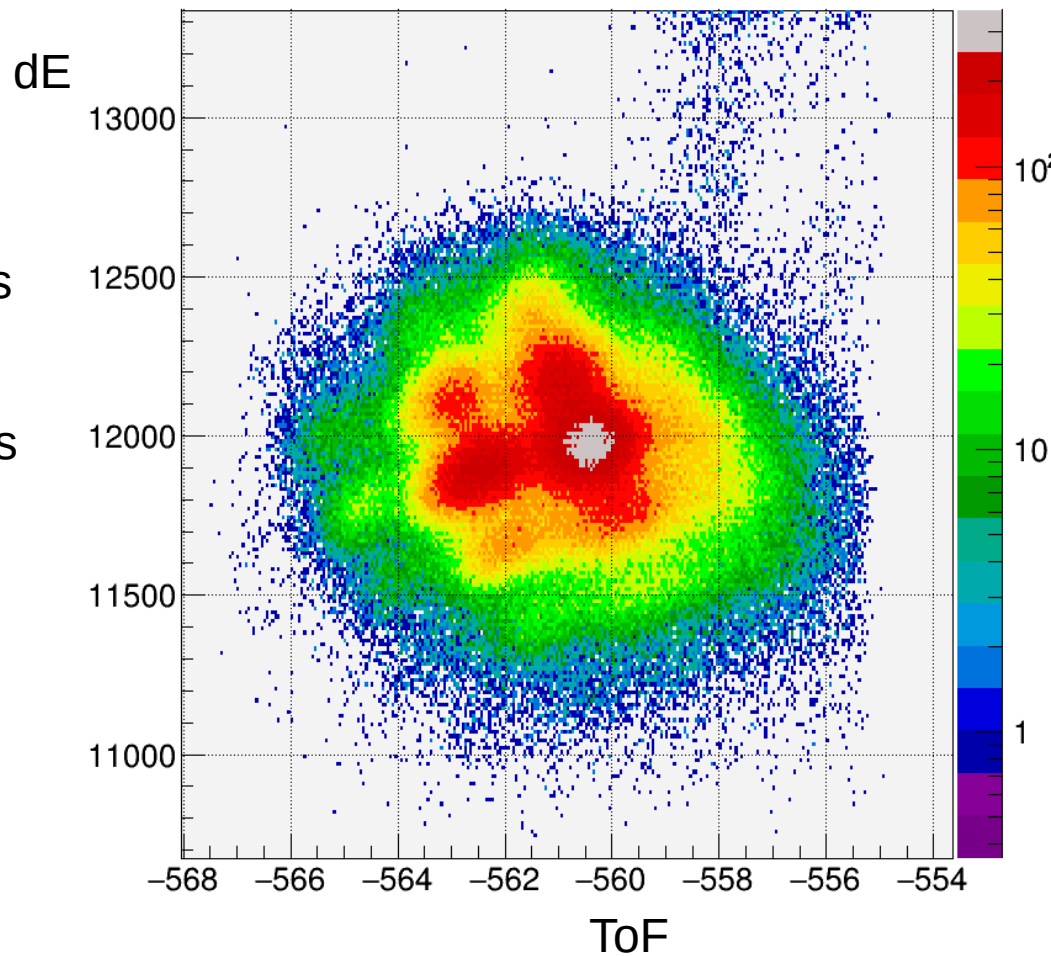
Analysis: Particle identification

“Basic” PID

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- each “blob” actually contains multiple isotopes

Add cuts:

- require correspondence between dE detectors
- gate on central trajectory (upstream PPACs)



Analysis: Particle identification

“Basic” PID

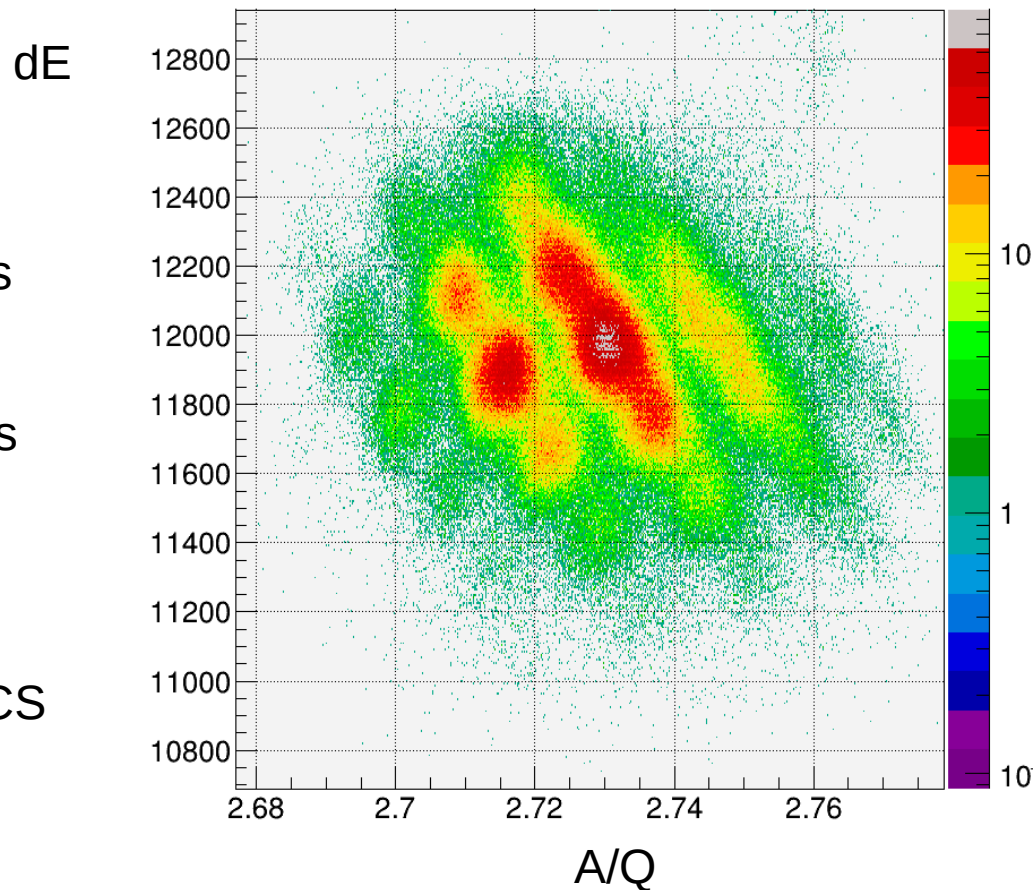
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ToF $\rightarrow$ A/Q

- correction for path length/trajectories using angle/position information from upstream PPACS



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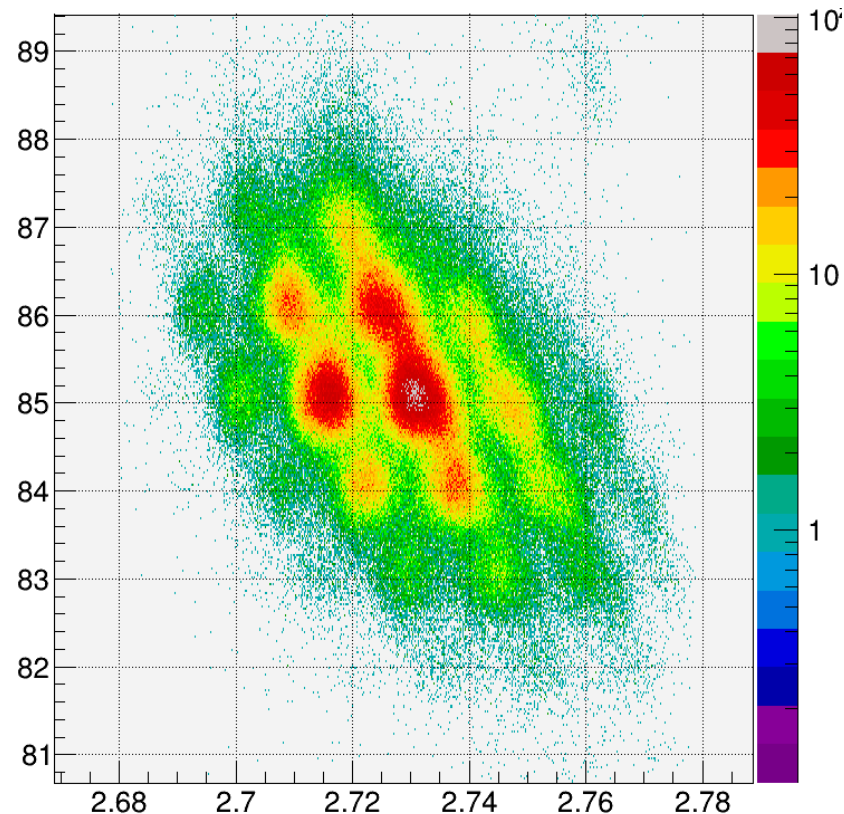
ToF $\rightarrow$ A/Q

- correction for path length/trajectories using angle/position information from upstream PPACS

dE $\rightarrow$ Z

- use several dE detectors in combination, calibrate to absolute Z

Z



A/Q

Analysis: Particle identification

Charge state selection

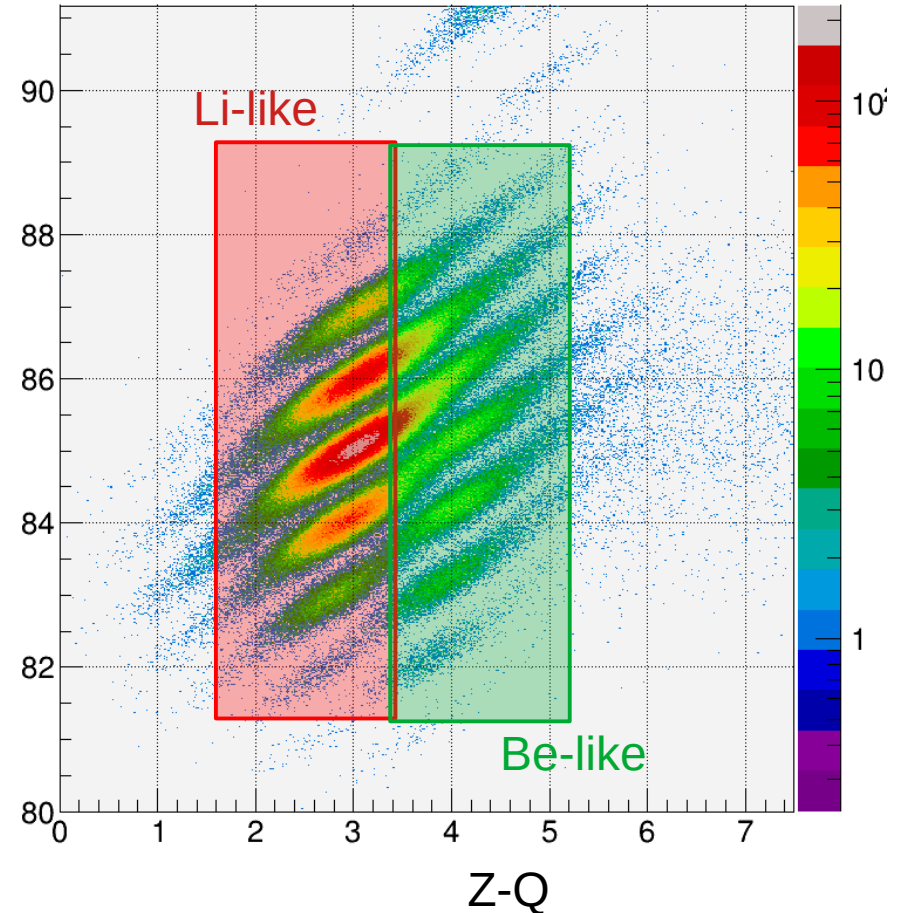
- Extract Q (charge) from the Total Kinetic Energy
- Requires accurate calibration of 4x dE detectors and the DSSD
- This is tricky: energies up to several GeV, dead layers, etc.

Achieve **good Q separation**

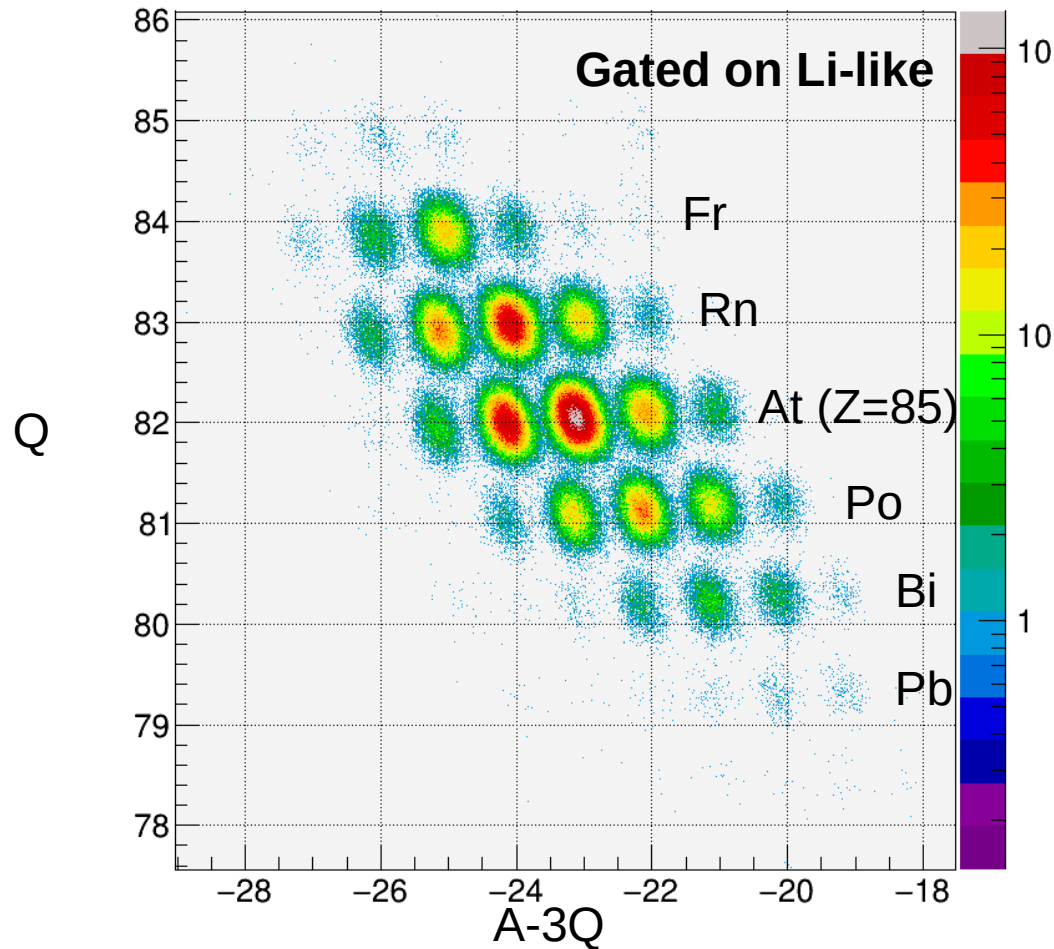
Z separation is **not so good**

Slight slope/separation depends on Z

Z



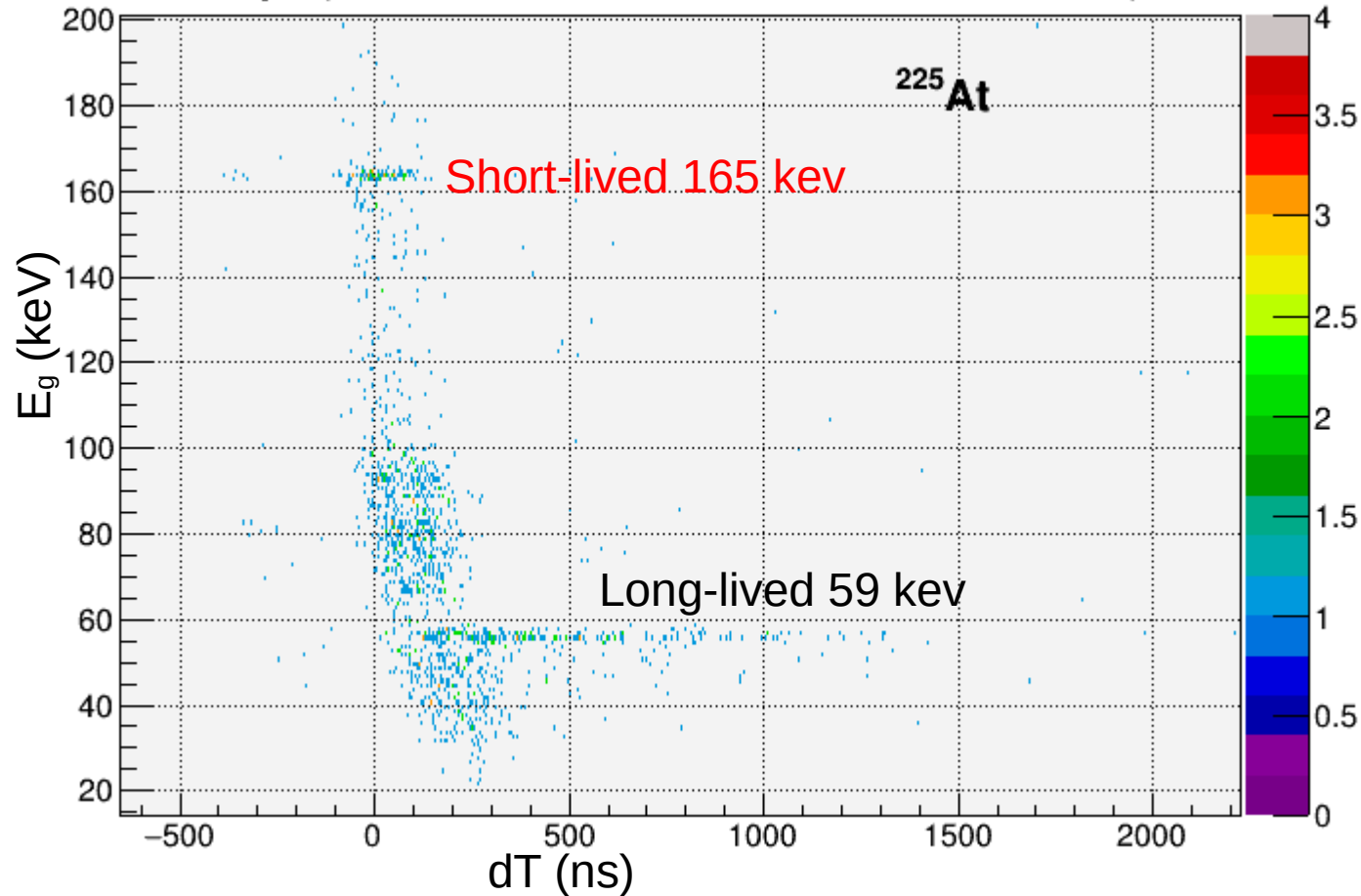
Analysis: Particle identification



Not perfect (isotope lines are sloped but should be completely horizontal)

Good separation between isotopes

Analysis: isomers

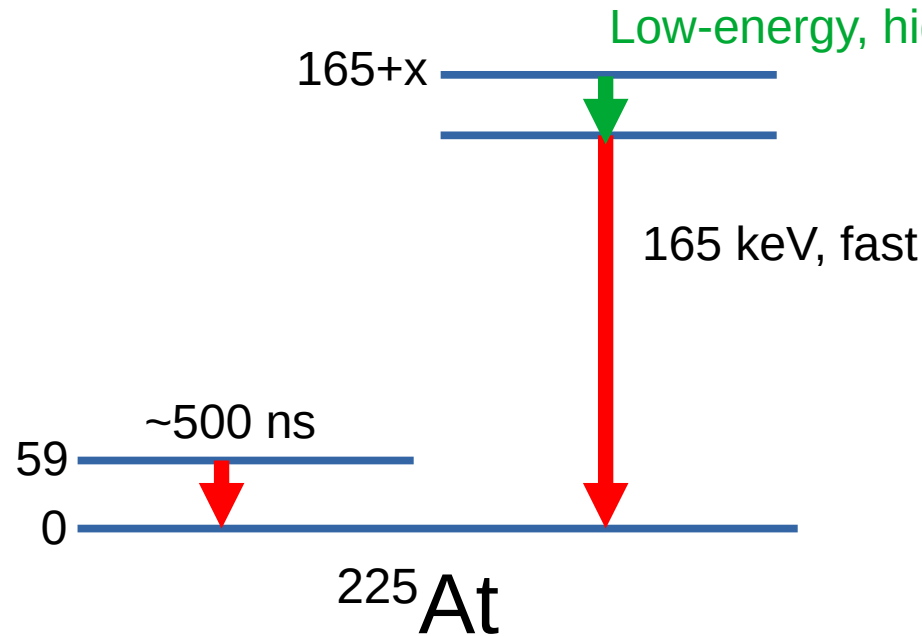


Gate on ^{225}At PID

How can we have
something so short-
lived?

(transit time through the
separator is ~ 400 ns)

Analysis: isomers



Low-energy, highly converted ($<100 \text{ keV}$)

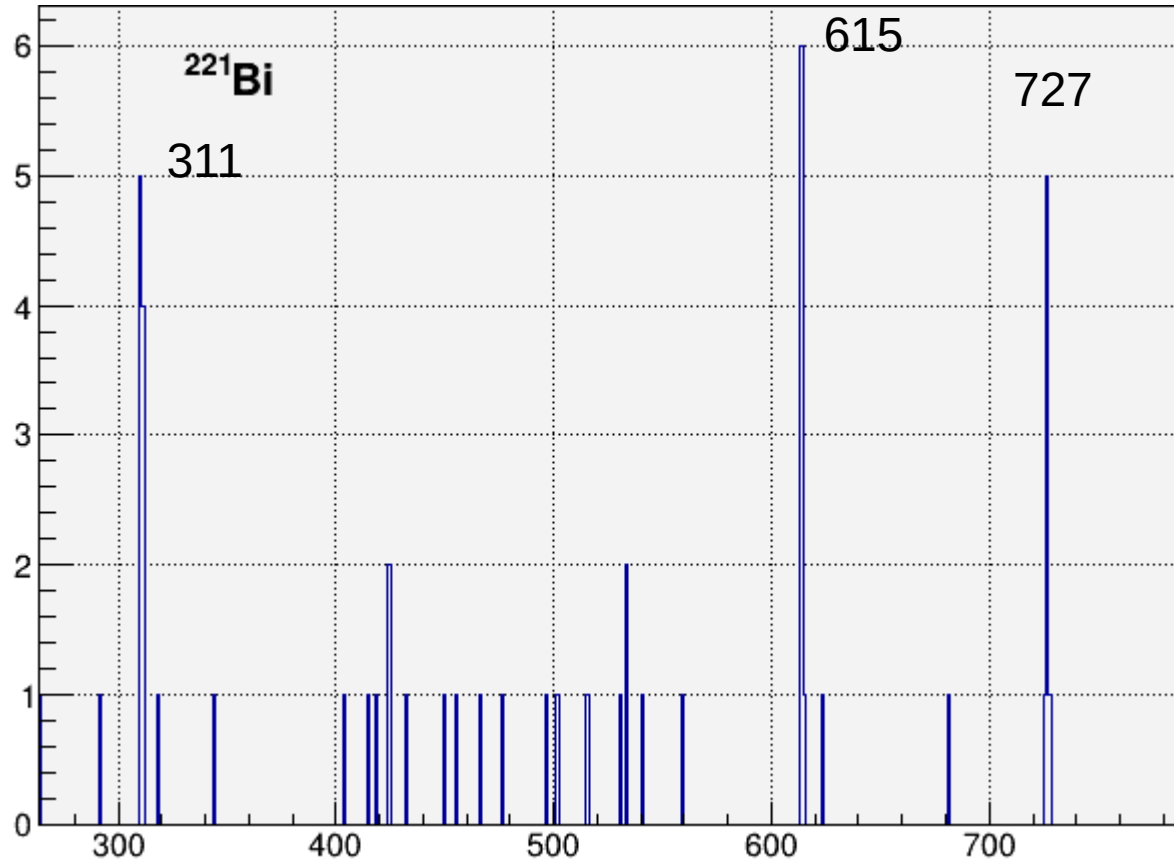
In transit, 2 or 3 electrons: **only k-shell conversion possible**

If the first transition is $<100 \text{ keV}$, **k-shell conversion is energetically forbidden**

=> no IC decay in flight is possible

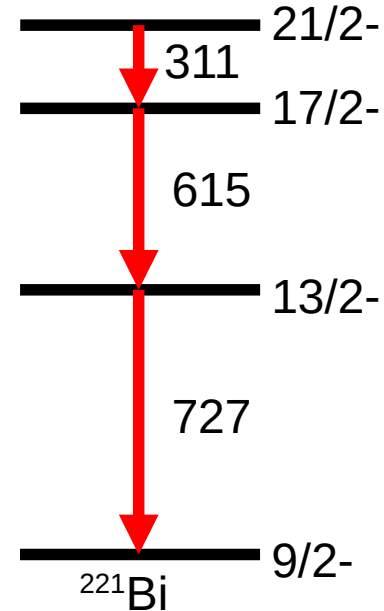
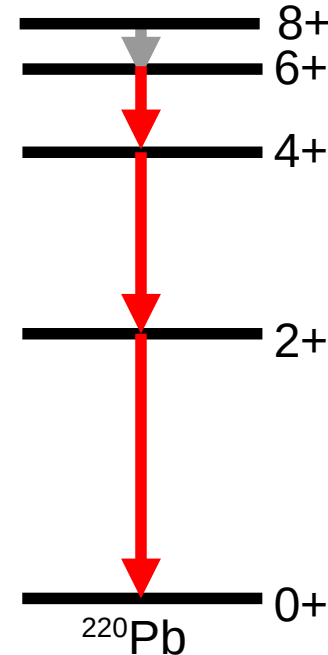
Once implanted, the nucleus is no longer in a $+82$ charge state and can decay promptly through L, M, N... conversion

Analysis: isomers

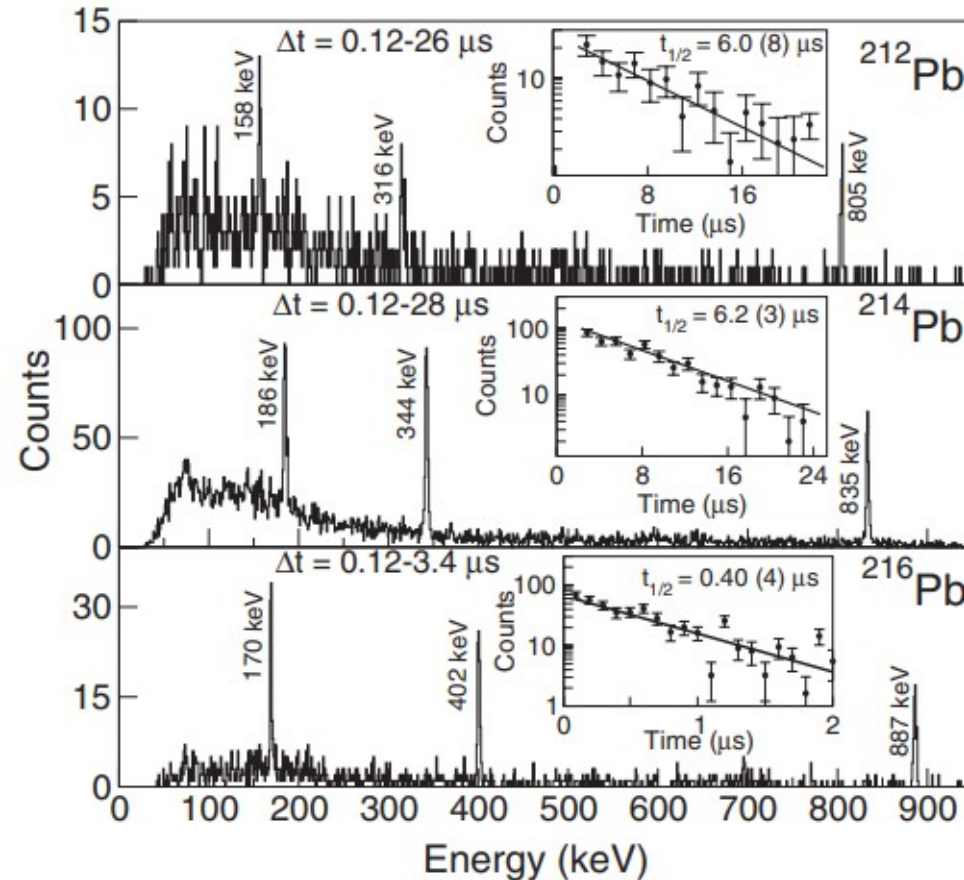
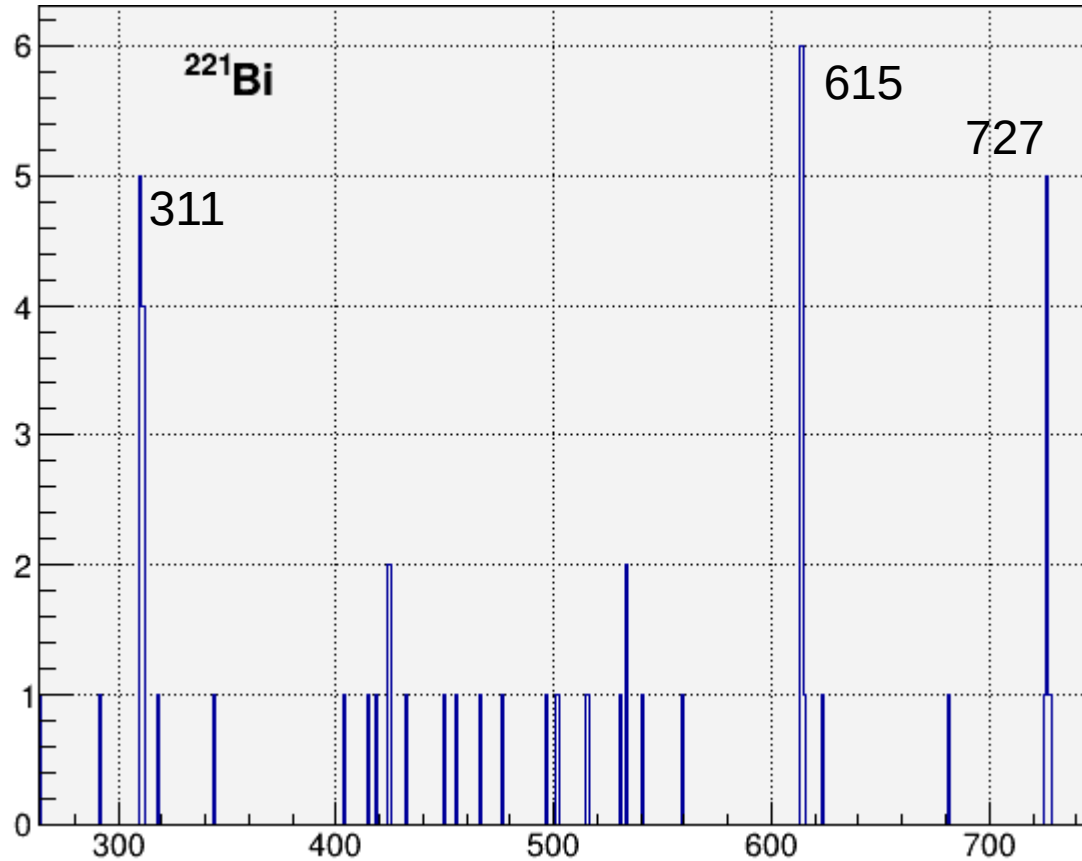


Isomer in ^{221}Bi ($^{220}\text{Pb} + p$)

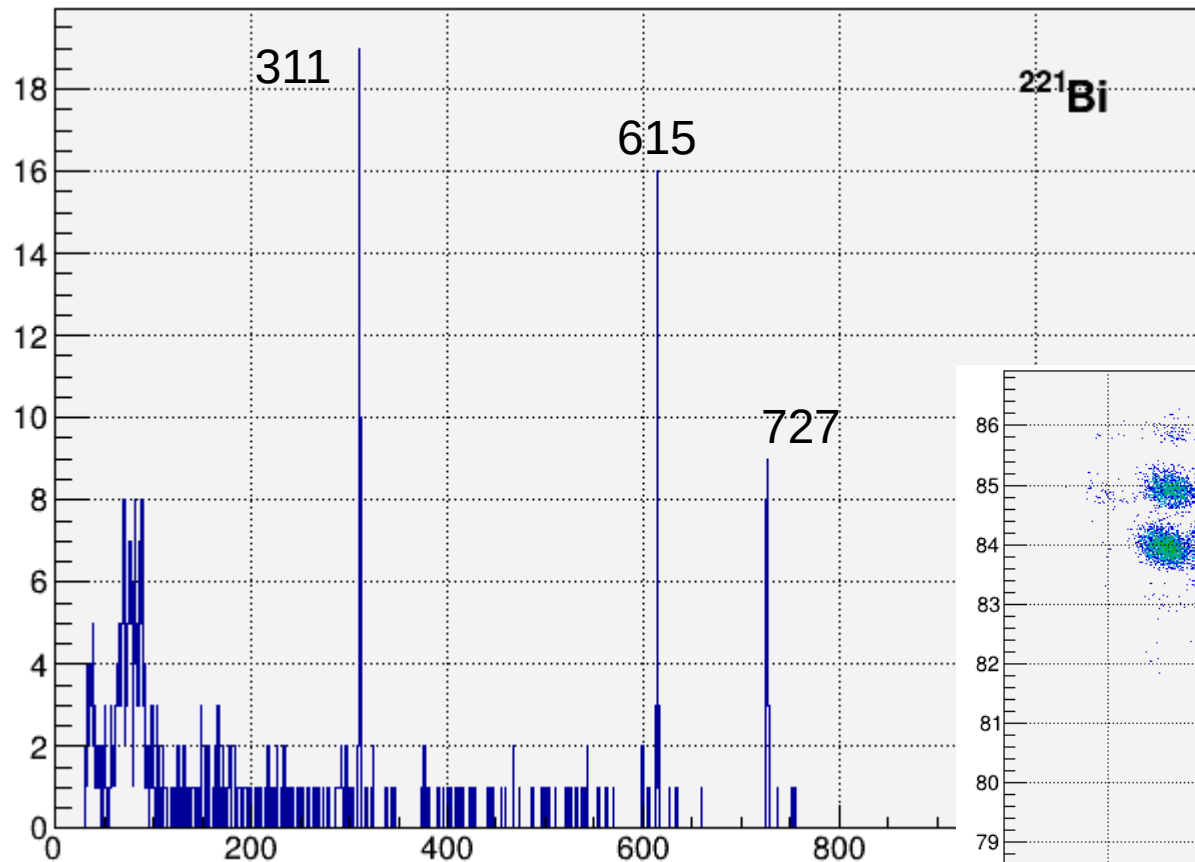
3 transitions suggestive of seniority structure



Analysis: isomers

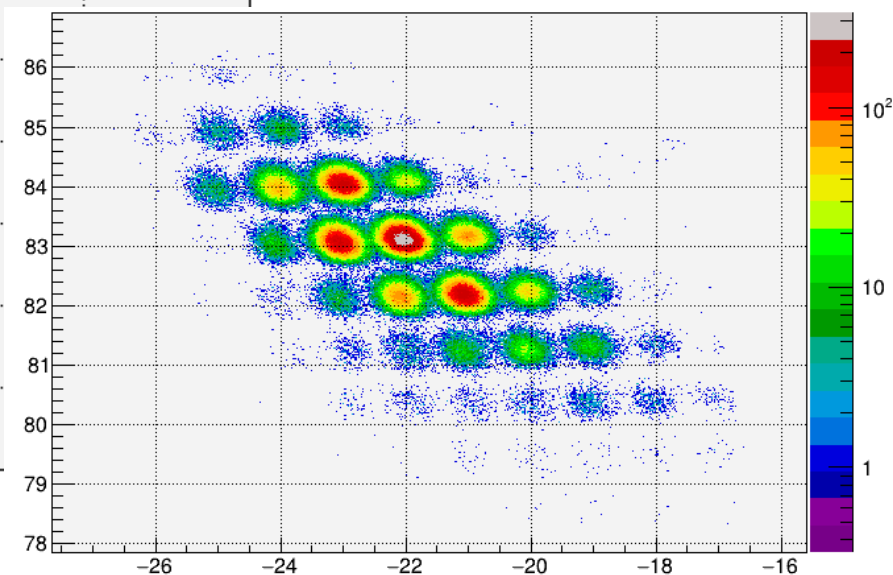


Analysis: other settings



5 settings total, between 7 and 40 hours each

- each requires adjustment and case-by-case corrections
- some overlap between each of them



Future work

- Finalize PID procedure – remove unwanted correlations, maximize Z resolution, finalize Si detector calibrations
- Finalize PID correction values for each of the 5 settings
- Catalog isomers in each setting and combine as necessary
- gamma-gamma coincidences where statistics allow

Theory calculations to **interpret isomers**, including **non-observation limits** for Pb isotopes and ^{219}Bi

